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Andrew J. McGowan Jr.

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SERUM BUTANOL EXTRACTABLE IODINE IN NORMAL CHILDREN TEN TO EIGHTEEN YEARS OF AGE

Andrew J. McGowan Jr.
B.S. College of the Holy Cross, 1954

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INTRODUCTION

The period between the ages of ten and eighteen years is a singularly important phase in the development of the individual, for it is at this time that many factors such as the adolescent growth spurt, sexual maturity, environment and emotional lability so profoundly influence the determination of future adult patterns. The physiological upheaval associated with puberty brings about a discrepancy between the young adult's biological maturity and childhood mental immaturity. Gallagher and the Adolescent Clinic Group in Boston have done much to emphasize the significance of treatment of the adolescent. (1, 2). While much has been written concerning psychological and physiological changes, including endocrinological development of the particular sex, little is known in this period about thyroid function, an important determinant in the metabolism of rapid growth. The importance of adolescent thyroid dysfunction as a common clinical entity has been mentioned by Van Wyk who attributes to the increased demands of adolescence sporadic simple goiters which occur in late childhood and adolescence (16). He also postulates that a defect in enzymatic synthesis of thyroid hormone may become apparent by enlargement of the gland in late childhood. Dr. Rawson, in New York City, has found a

high incidence of goiters in adolescent boys from this north-east section of the U.S.A. These boys were having routine physical examinations for a summer Boy Scout Camp. Male adolescents have an accelerated increase in weight of muscular tissue between the ages of 12 and 16 years and the increase in muscular tissue would be directly related not only to rapid peripheral utilization of thyroid hormone but also to continuous adequate production of this hormone by the thyroid gland.

The first significant data on thyroid function studies in children of the age group 10 to 18 years is that of Danowski et al. in 1951 on the protein bound iodine (3). In the earlier work of Fashena (4) on total blood iodines, no difference in values was found between the sexes; however total blood iodine cannot be correlated with the more recent PBI determinations for the following reasons: total blood iodine includes any inorganic iodine in addition to the iodine compounds of serum which precipitate with protein; since the red blood cells do not contain appreciable amounts of organically bound iodine, a definite volume of blood contains only about half the PBI in an equal volume of serum.

Du Bois (5) did some of the original determinations of basal metabolic rate in children, and Peters and Van Slyke (6) applied his standards to the adolescent period of life, showing a drop in basal metabolic rate with advancing age.

It must be remembered that basal metabolic rate is based on utilization of oxygen by peripheral tissues. The work of this thesis concerns a measure of thyroxine-like or butyl extractable iodine (BEI) (7) in the plasma transport system, and as such is not necessarily a measure of metabolic activity in peripheral tissues.

The serum BEI is more specific for evaluation of thyroid activity than is SPI (8) (serum precipitable iodine or protein-bound iodine) since the former determination eliminates the confusing effects of ingested inorganic iodine, (9, 10, 11) or inborn errors of synthesis of certain metabolically inactive iodine compounds. The measurement of BEI does not eliminate false high values following use of diagnostic iodine-containing compounds (11, 12).

The normal ranges of BEIs have been defined in the serum of infants (11), normal children under the age of ten (14), and adults (15), and are 7.2 to 13.2, 4.5 to 7.3 and 3.2 to 6.4 gamma per cent respectively. Since values for euthyroid children are so much higher than those of adults, the normal BEI range for that group lying between the ages of ten and eighteen years attains a particular clinical significance.

The BEI has special diagnostic value for that group of adolescent girls who develop goiters associated with lymphocytic thyroiditis. PBIs of many of these girls were

elevated to higher concentrations by inclusion of abnormally large amounts of non-butanol-extractable, calorigenically inactive iodine substances than was anticipated by clinical observation (17). The Boston Adolescent Clinic Group had emphasized that hypothyroidism is often falsely diagnosed because of certain misconceptions which have arisen in relation to different developmental patterns of adolescents. For example, obesity at this age may be normal to the individual and not a diagnostic sign of hypothyroidism (18). This point will be upheld later by the data of this investigation.

Since diagnosis of thyroid disease is so difficult in this age group, this investigation is concerned with the range of BEIs for normal children age ten to eighteen years.

MATERIALS AND METHODS

The children included in this project were divided in two groups. Group I consisted of ten girls and ten boys who were contacted for the sole purpose of acting as euthyroid subjects for this study. The children were included as normal controls in relation to critical clinical evaluation based on history and physical examination. A special form was used to record significant data (Appendix). Explanations of topics contained in the form appear below.

Group II consisted of three post-rheumatic fever patients who were considered by their pediatric cardiologists to be euthyroid, and of ten children whose physicians requested BEI determinations to exclude the question of thyroid dysfunction. All subjects in Group II were subsequently classified as clinically euthyroid in spite of the presenting symptom which had previously prompted confirmation of thyroid status by chemical evaluation. The particular reason for request of each BEI is listed in Table II. Eberlein and workers state that 15-25 per cent of patients referred to a pediatric endocrine clinic are obese (19) and indeed three of the females and two of the males of Group II entered the pediatric clinic at Grace-New Haven Hospital with that complaint. All those cases of obesity which were

followed lost weight on adherence to diet. Wilkins has observed that hypothyroidism leads to diminution rather than increase in appetite (20). Bruch noted that almost always the obese child contradicts symptoms of hypothyroidism because he or she for the age is actually taller than average and has an advanced bone age (21).

The following are the topics used on the questionnaire in evaluating Group I:

Family history: It was originally intended that no child would be classified as normal who had a close relative with thyroid disease, however following the BEI determinations on five of the subjects whose blood had been sent from another city, (the W sisters: V,S,M,L, and BW) it was found that their mother had been on desiccated thyroid therapy because of a low basal metabolic rate during each of her pregnancies. If the family history had been available earlier, the specimens would not have been obtained. These children were considered euthyroid by their physician father, and their mother took thyroid regularly only during her pregnancies. The basal metabolic rate is difficult to evaluate accurately during pregnancy because the weights of the placenta and fetus alter the factors used for calculations, and also the elevation of the diaphragm influences breathing. Smith's report that hypothyroid women did not require as much desiccated thyroid during pregnancies relates to the availability to the mother

of thyroid hormone from the fetus (22). No other symptom of the mother W. except the low BMR suggested hypothyroidism. These five daughters have been placed in Group I. Family history of other metabolic disorders was not discovered in any other subjects.

Birth history: This section was used to determine whether there had been a normal, uncomplicated delivery. Here again the use of thyroid or antithyroid medication during pregnancy was a contraindication to inclusion in this study. In addition to the work of Smith mentioned above, Engstrom (23) and many others have reported goiter present at birth in children born to hyperthyroid women under active treatment with normal or large doses of antithyroid medication. Use of antithyroid medication has not been under clinical observation long enough to determine its ultimate effect on thyroid function of the child born to a mother under therapy for hyperthyroidism during pregnancy.

Somatic development: The physique of the patient was compared to that of other members of the family in order to discover any familial tendency in stature. Low mental capacity would place the patient in an abnormal category.

Recent illnesses or infections: If there had been any acute infections or exanthemata within the month prior to the determination, the patients would not have been considered to have a normal BEI. Walker showed that there was an initial

drop and secondary rise in SPI before return to normal in four adult pneumonia patients (24), and Durham et al. reported low BEIs when children were acutely ill (14).

Growth Spurt: It is known that in general the velocity of growth decreases from birth, to be interrupted by increases only twice during one's life, first by the juvenile spurt and secondly by the adolescent spurt. Tanner observed that the latter, though variable in intensity and duration, is a constant phenomenon occurring in all children. Boys average a height and weight gain of about eight inches and forty pounds respectively from age 13 to age 15½. Girls average a height gain of only 3¼ inches at ages 11 to 13½ years (25). Thus there may be increased peripheral utilization of thyroid hormone during adolescence. Van Wyk noted that sporadic simple goiters occurring in later childhood or adolescence are usually asymptomatic and tend to get smaller after adolescence (16). Since most of the subjects of this study were in good health and under the care of private pediatricians, no record of serial testing of growth was available, and figures recalled by the patients themselves were at best approximate. Only future followups of the younger subjects would indicate whether they were undergoing marked acceleration of growth at the time of these determinations.

Menarche: Particular interest was paid to the onset of menstruation and the possibility of a trend toward higher or lower values of the BEI in this period of functional change with its accompanying psychological import. Shock in 1943 measured basal metabolic rates as well as blood pressure and heart rates in relation to growth spurt and menarche and found that at menarche there was a sharp fall of basal metabolic rate to adult levels (26).

Thyroid system review: A careful survey was made to discover any symptoms of thyroid dysfunction prior to physical examination, and these symptoms are listed on the form.

Physical examination: Height and weight were recorded and percentiles used giving a value representative of a particular position in any typical series of 100 children, the 50th percentile representing the median or midposition in the customary range. These percentiles were taken from the reproductions of Merideth of the Iowa Child Welfare Research Station (27). The weight percentiles depend on chronological age and are not corrected for height, so that a tall child may have an elevated weight percentile. The third and ninety seventh percentiles represent unusual though not necessarily abnormal findings, and in this study two subjects of Group I were considered normal though over the ninety seventh percentile in height and weight.

During the physical examination special emphasis was

placed on a search for signs of hypo- or hyperthyroidism such as coarse or fine skin, coarse or silky hair, thyroid enlargement, nervousness, lethargy or tachycardia. Heart and lungs were auscultated as part of the general examination.

Physical development was graded on the basis of breast development and pubic and axillary hair distribution in females; and facial, axillary and pubic hair as well as size of genitalia in males. Breast development was divided into infantile, bud, primary and secondary mamma as described by Hamblen (28). Female hair distribution was based on the criteria of Tanner (29), and male sexual development on the work of Greulich (30).

METHODS

Following the history and physical examination, 15-20 cc. of blood was withdrawn from the antecubital vein. History taking had eliminated possibility of contamination of blood with medication or contrast medium iodine, and only medicated alcohol was used to prepare the site of venipuncture. The sample was placed under oil, centrifuged, and the serum separated within 60 to 120 minutes from the time of venipuncture. In five subjects of Group II, serum iodines had been determined some years ago by the SPI method (31), and such are designated by asterisks. The determinations by the SPI method are recorded in the tables and graphs as BEIs (SPI-0.5 gamma per cent = BEI (13)). All others were done by the BEI method of Man, Kydd and Peters (11). Averages of determinations done in duplicate and agreeing within one gamma per cent are recorded.

Physiological age as well as chronological age was a necessary consideration; the most commonly used indication of functional development is skeletal age as determined radiologically. Sequential appearance of ossification centers and fusion of epiphyses present have been used to determine the normal stage of development for a given age. The hand-wrist is the most practical area for the present age range,

and Todd's standards for the development of that area (32) and the more recent revision of Greulich and Pyle are the classical works in this field. Hand-wrist studies, and in one case elbow films, were made on as many subjects as possible. Assessment of the bone age was done by the author according to the method outlined in the atlas of Greulich and Pyle (33).

RESULTS

All tables contain BEIs of subjects listed in order of increasing age. Table I is divided into two parts: the first containing ten normal females with fifteen determinations done for research purposes rather than for exclusion of thyroid dysfunction; and the second composed of determinations done on ten normal males. Listed in Table I are birth date, date of determination, BEI, chronological age, bone age, height and weight percentiles and secondary sex characteristic development, the latter including in females breast shape; pubic and axillary hair distribution (graded 1-4); age at menarche and number of months since establishment of regular menstrual cycles. In males general classification graded (1-5), based on criteria mentioned previously, was determined. Dashes in the appropriate columns designate instances where certain information was unavoidably not obtainable. Table II, also divided into males and females, contains similar information, and with the addition of the symptom or sign leading to request for BEI determination.

In Graphs I-a, b, and c, the chronological age in years and months is plotted against corresponding BEI values for clinically euthyroid male and female children and adolescents of both sexes (Table 1). In Graph II are shown

chronological ages plotted against BEI values for children whose determinations were originally done to rule out hypo- or hyperthyroidism (Table II). Graph III is a composite of I and II.

Graphs IV and V show weight and height percentiles respectively for composite Groups I and II plotted against BEIs. Graph VI shows relationship between number of months after regularity of menstrual cycle and BEI, and finally Graphs VII-a and b compare BEIs, chronological and bone age, and gradation of secondary sex characteristics for males and females of Group I. (Secondary sex characteristics of females are graded 1-4, and the single number represents the average of the original categories mentioned above.)

All 39 BEIs on 20 clinically euthyroid children and on 13 adolescents of Group II were between 3.5 and 6.5 gamma per cent. Only 3 BEIs were above 5.3 gamma per cent. Thus the minimum for adolescents appears to be slightly above the minimum of 3.2 gamma per cent for adults but lower than the minimum of 4.5 for children under the age of 11 years. The narrow range in the group of 33 adolescents is obvious from the tables. Examination of Graphs I-a, b, and c does not permit definition of characteristic distribution of BEI in relation to chronological age. Six of ten males are between ages of $10\frac{1}{2}$ and $12\frac{1}{2}$ years, and the remaining four subjects are the only male adolescents between ages $12\frac{1}{2}$ and 18 years

of age. Though not numerically significant, the range for five of six girls between ages 11 and 14 years was extremely narrow: between 3.5 and 4.0 gamma per cent.

In Graphs II and III only three of thirty-six values lie above 5.3 gamma per cent, and none of these exceeds 6.5 gamma per cent. Two of these subjects, E.S. and C.M., were girls who had suffered attacks of acute rheumatic fever some years preceding the iodine study, and both had been considered euthyroid and of normal cardiac status clinically and electrocardiographically for several years. Subject C.C. was also in the same historical category but had a BEI of only 3.7 gamma per cent. Further studies are necessary on post-rheumatic fever patients as well as normal adolescents before any possible connotation can be placed on these two high figures. An attempt is being made for follow up on the third subject with a high value: E.J., a remarkably obese boy of 14 years 6 months age who had a BEI of 6.4 gamma per cent and has since undergone a growth spurt of approximately ten inches in less than four years.

Study of Graphs IV and V shows no specific pattern in the relationship of height and weight percentiles and the BEI. Graph VI fails to show a tendency for BEI value to diminish as the time after menstrual onset is increased, as one might have postulated from the previously mentioned drop in the BMR post menarche. Nor does there appear to be anything

characteristic about the BEI before menarche except that three of four premenstrual girls aged 11 years 9 months to 13 years 9 months had values below the minimum normal limit for children up to age ten, and the fourth had a value of the exact lower limit of normal (4.5 gamma per cent) for that age group.

From Graphs VII-a and b no correlation is apparent between advance in sexual development and BEI value. Relation of BEI to bone age as seen on Graph VIII is non-specific. In the females skeletal age was close to chronological age in all instances, however such was not the case in the male group whose bone age extremes ranged from 19 months ahead to 19 months behind chronological age. One male, J.H., of chronological age 12 years 5 months and skeletal age of 11 years also had a pectus excavatum which did not, however, cause any cardiorespiratory embarrassment. Height and weight percentiles were in the 65th and 60th percentiles respectively, and he bordered on stage three of sexual development.

Table I contains repeat determinations at various intervals on five female patients. S.L. and P.L. are sisters who were used as subjects in the previous study on BEIs of normal children under age ten (12). Six years and two months after the initial determination, their BEIs had dropped 0.9 and 0.6 gamma per cent. The BEI of A.B., the

only other female used in the same study diminished 0.7 gamma per cent in approximately the same amount of time. S.W. and V.W. are sisters, and although the latter is now 19 years 7 months old, a repeat determination done in a 3 year 1 month interval diminished insignificantly, 0.2 gamma per cent. S.W. was the only female subject whose repeat showed a rise: from 3.7 to 5.1 gamma per cent in 3 years 2 months.

Group II of Table II shows follow up determinations on two males, one of whom was 18 years 9 months on repeat. The BEI of L.M. rose from 4.5 to 5.1 gamma per cent, however he had suffered from infectious mononucleosis about three months prior to the initial determination, and was diagnosed as post infectious asthenia. Complete recovery one year later may account for the rise in BEI. C.M., an obese male with Osgood-Schlatter's disease, showed a decrease of 1.0 gamma per cent over a period of 2 years 4 months with improvement in his orthopedic defect treated by restriction of all strenuous activity. His growth has been gradual,

DISCUSSION

Of the total of 39 determinations only three were above 5.3 gamma per cent, and two of these were the forementioned post-rheumatic fever patients. The third was a male whose BEI was measured to exclude hypothyroidism. This boy had not yet undergone the growth spurt. While it is obvious from this study that many adolescents who had not yet spurted in growth had BEIs not elevated above 5.3 gamma per cent, a follow up determination on this boy is planned to see whether this high concentration has persisted after his rapid growth phase.

In the clinically normal group of 25 determinations, the minimum BEI of 3.5 is significantly below the childhood (up to ten years) minimum of 4.5 gamma per cent. This minimum value and values within 0.3 gamma per cent higher were seen in six females and three males. In addition to the values in the normal group, no values in 15 determinations on adolescents now classified as euthyroid was below 3.5 gamma per cent. It is true that many of the bloods were obtained after school in the late afternoon when any afternoon diurnal rise in BEI, if such occurs, was not investigated because repeated venipunctures were not warranted in this age group.

One boy, 11 years 2 months old, not listed on any tables, was a diagnostic problem three years before these data were collected, and his clinical course was studied critically. A two month trial on minimum dosage of desiccated thyroid, after a BEI of 3.3 gamma per cent, was unsuccessful in relieving symptoms of lethargy and obesity, which symptoms have persisted until the present time. This patient's private physician considers that this condition may be the result of a behavior problem; however, the short trial on low doses of thyroid was insufficient to prove failure of response to therapy, and in view of the findings of this investigation, he may well be hypothyroid. A subsequent BEI upon his return from school may support this provisional diagnosis.

In view of a difference in range of 3.2 gamma per cent in adults (3.2 to 6.4) and 2.8 gamma per cent in children under ten years (4.5 to 7.3), a range in our group of as little as 1.8 gamma per cent (3.5 to 5.3) was not anticipated and additional studies are necessary to establish so narrow a range. On the other hand, all of the 20 euthyroid adolescents in Group I were observed during the winter months and the low BEIs might correlate with the season of the year when, as quoted by Tanner (34), adolescents lose weight. It should be noted here that no attempt was made to correlate season of year with BEI. It might be possible to attribute the lower minimum and narrow range to the tremendous physical

and physiological changes in this age group.

Heald in some preliminary investigations of the protein bound iodine of adolescents thought a relationship might exist between sexual maturity and PBI value (35). He also noted a tendency toward higher PBIs in heavy children and lower values in children of lesser weight. This has not been supported by our data on as small a group as presented here. With the BEI there is not the wide range that Heald has found (approximately 4 to 8 gamma per cent). Danowski (3) did not present his data to relate the PBI to normal physical variations. He summarized his observations on 64 subjects aged 6 to 18, including both normals and diabetics (whose values did not vary appreciably from normals) that the protein bound iodine averaged 4.7 ± 0.8 gamma per cent. Oliner found that thyroidal 24 hour and 48 hour I^{131} uptake values for normal children up to 18 years of age were within the normal adult range and were not affected by body weight or sex. His PBI^{131} values indicated a state of physiological hyperactivity which decreased gradually from age four to age ten when the adult euthyroid mean was approached (36). However, only six children in an age range comparable with the ages of children who had BEI measurements would appear to correspond with our criteria for selection of subjects.

Since 33 subjects had 39 BEIs of 3.5 gamma per cent or over, adolescents with BEIs below this value should be

carefully examined for signs of hypothyroidism, and any value below the adult minimum of 3.2 gamma per cent should be considered definitely abnormal. It would be of interest to list BEIs of clinically frank hypothyroid children in this age group. The advisability of administering or withholding desiccated thyroid to or from borderline hypothyroid adolescents is not clear. It is known from studies on borderline hypothyroid and euthyroid adults that administration of thyroid may temporarily depress endogenous release of thyroid hormone (37-39). Findings in this laboratory indicate that certain hypothyroid adolescents, although the number of hypothyroid adolescents observed adequately is small, frequently require three grains of thyroid to raise their BEIs to low normal adult levels (above 3.2 gamma per cent). Another example of the demand for thyroid hormone during this adolescent age is exhibited by the lability with which a hyperthyroid adolescent is converted to clinical hypothyroidism by antithyroid medication.

As mentioned in the introduction, the caloric expenditure per square meter per hour, and consequently the high basal metabolic rate seen in early adolescence reflects increased metabolism in the peripheral tissues. Three different tables of calculations of calories per square meter which were presented by Peters are indicative of the individual physiological change in adolescence. During adolescence up to the

age of 19 years for females and until 20-21 years for males, the decrease toward adult values as calculated yearly in males is slightly more rapid, though rates for the same age are consistently lower in females (6).

If thyroxine-like iodine concentrations are not as high as the euthyroid minimum it might be assumed that transfer of this hormone from the plasma to the peripheral tissues may be retarded or impaired. In such a situation, metabolic underactivity would be more abnormal than suggested by the concentration of the BEI. In hypothyroidism when minimal replacement therapy is given, the BEI assumes a concentration between the original hypothyroid state and euthyroidism. Additional replacement therapy may increase metabolic functions simultaneously with a small rise in BEI. The paucity of the rise suggests acceleration of the rate of transfer of hormone to the tissues with simultaneous increase in utilization or destruction of thyroxine-like iodine. Thus a minimum serum BEI in adolescence, a period of stress in development when excessive amounts of thyroid hormone may be in demand, may present a situation in which temporary administration of desiccated thyroid might augment physical and mental development (40).

The final solution of the problem of thyroid therapy in adolescents can only be solved as the result of further investigation. Definition of the normal BEI range in this age group is an important basic step in the initiation of this task.

SUMMARY AND CONCLUSIONS

1. The BEIs of 20 normal children between the ages of ten and eighteen years have been determined. Careful clinical histories were taken, and physical examinations done.
2. The BEIs of ten children were measured to rule out thyroid dysfunction. These children were subsequently classified as euthyroid. BEIs were determined on three post-rheumatic fever, clinically euthyroid children.
3. All BEIs from the three groups above were 3.5 gamma per cent or above that figure. The maximum BEI was 6.5 gamma per cent, and 36 of the 39 BEIs were 5.3 gamma per cent or lower. The continuous demand of the adolescent for peripheral supplies of thyroid hormone is discussed.
4. The minimum value for these 33 children in this age group was 3.5 gamma per cent. Although the maximum value appeared to be 6.5 gamma per cent, this could not be established definitely on so few subjects.

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T A B L E I

NORMAL MALES AGE 10-18 YEARS

Subject	Birth Date	Date of Determ.	BEI gamma %	Chron. Age	Bone Age	Ht. & % Inches	Wt. & % Pounds	Secondary Sex Devel.
JL	8/8/47	2/8/58	4.9	10'6"	13'3"	62" 97	90' 83	0
EM A92280	5/17/40	1/15/52	5.0	11'8"	----	54" 20	80' 50	-
CH	5/3/46	2/6/58	3.5	11'9"	13'3"	64" 95	138' 97	1-2
CL	2/1/46	2/8/58	4.9	12'	13'3"	58" 40	97" 75	0
RM	11/8/45	2/3/58	4.3	12'3"	11'	60" 65	84' 45	1
JH	8/22/45	2/3/58	3.8	12'5"	11'	60" 65	94' 60	2-3
SC	10/2/44	2/11/58	3.8	13'4"	13'3"	58" 7	88' 25	0-1
LW	8/2/44	2/5/58	4.4	13'6"	13'3"	65" 80	105' 60	3
HM	5/21/42	2/5/58	3.8	15'9"	14'	68" 53	128' 47	3-4
MN	10/28/40	12/20/57	5.0	17'2"	19'	68" 45	148' 65	4

T A B L E I

NORMAL FEMALES AGE 10-18 YEARS

Subject	Birth Date	Date of Determ.	BEI gamma %	Chron. Age	Bone Age	Ht. & % Inches		Wt. & % Pounds		Secondary Sex Devel. Breast	Pub. Hair	Ax. Hair	Men. at Age	Mos. Men. reg.
RL	11/8/46	2/6/58	3.7	11'3"	12'	61"	83	127'	97	1	2	2	0	
LW	9/7/46	2/2/58	3.5	11'5"	--	59"	65	81'	45	0	0	0	0	
BW	9/7/46	2/2/58	4.0	11'5"	--	57"	37	70'	18	0	0	0	0	
SL 36-62-37	7/4/44	12/3/51	4.6	7'5"	--	--	--	--	--					
		2/6/58	3.7	13'7"	14'	60"	15	105'	50	2	2	2	12	19
JW A 50972	10/18/38	1/29/52	4.5	13'9"	--	--	--	108'	50	2	2	0	0	
AB C 63019	8/29/43	10/9/51	5.3	8'2"	--	--	--	--	--					
		1/24/58	4.6	14'5"	15'	63"	55	138'	90	4	3	3	11	41
MW	2/15/43	2/2/58	3.5	15'	--	63"	45	105'	25	2	3	3	12	24
PL 36-62-36	4/28/42	12/31/51	4.9	9'8"	--	--	--	--	--					
		2/6/58	4.3	15'10"	17'	60"	7	118'	50	3	3	3	13	Irreg.
SW	3/7/41	12/1/54	3.7	13'9"	--	--	--	--	--					
		2/2/58	5.1	16'11"	--	69"	97	135'	80	4	4	4	--	--
VW	6/1/38	12/1/54	3.9	16'6"	--	65"	70	125'	70	4	4	4	12	50
		1/14/58	3.7	19'7"	--	65"	--	145'	--	4	4	4	12	86

T A B L E II

MALES WITH QUESTION OF THYROID DYSFUNCTION

Subject	Unit #	Birth Date	Date of Deter.	BEI	Chron. Age	Bone Age	Ht. & % Inches		Wt. & % Pounds		Secondary Sex Devel.	Purpose of BEI
CM	B 49919	11/9/43	10/14/55	5.1	11'11"	--	60	75	140	97		
			2/11/58	4.1	14'3"	15	67	93	190	97	3-4	Osgood-Schlatter Overweight
ED		12/3/39	6/17/54	6.4	14'6"	--	62	20	180	97	4	Overweight Low BMR
JD	A 71561	1/12/30	10/17/45	4.8*	15'9"	--	63	10	163	90	3	Sluggishness
DC	C 7747	3/25/32	2/23/48	3.6*	15'11"	--	--	--	---	--	-	Trachycardia
TC	42-60-25	10/3/38	4/9/55	4.3	16'6"	--	--	--	185	97	5	Behavior Disorder
LM	A 68007	12/15/36	8/24/54	4.5	17'8"	--			215	97	5	Post-infectious Asthenia
		≠	9/14/55	5.1	18'9"	--						

* Done as SPI

≠ = Repeat Determination at Age Beyond 18 Yrs.

T A B L E II

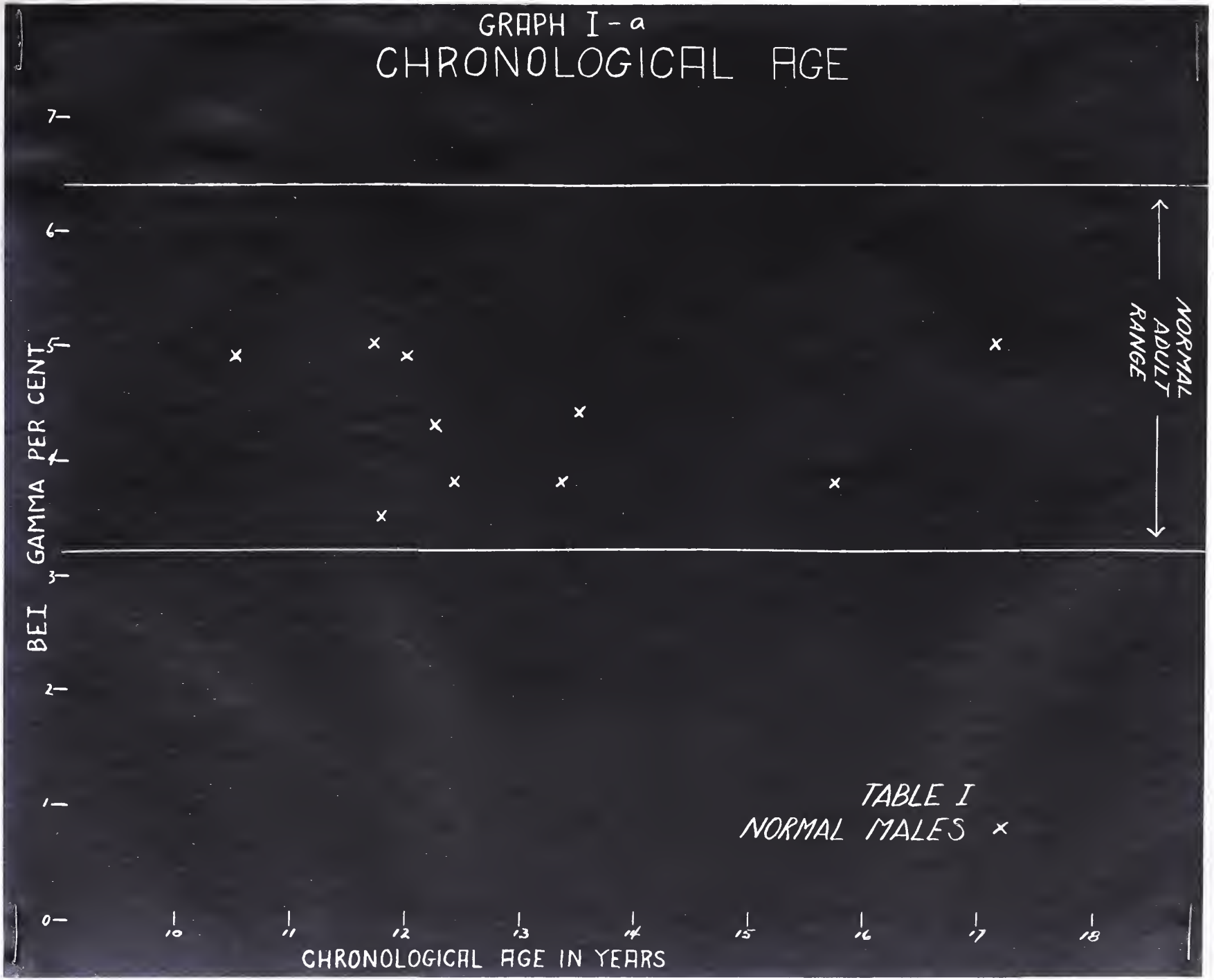
FEMALES WITH QUESTION OF THYROID DYSFUNCTION

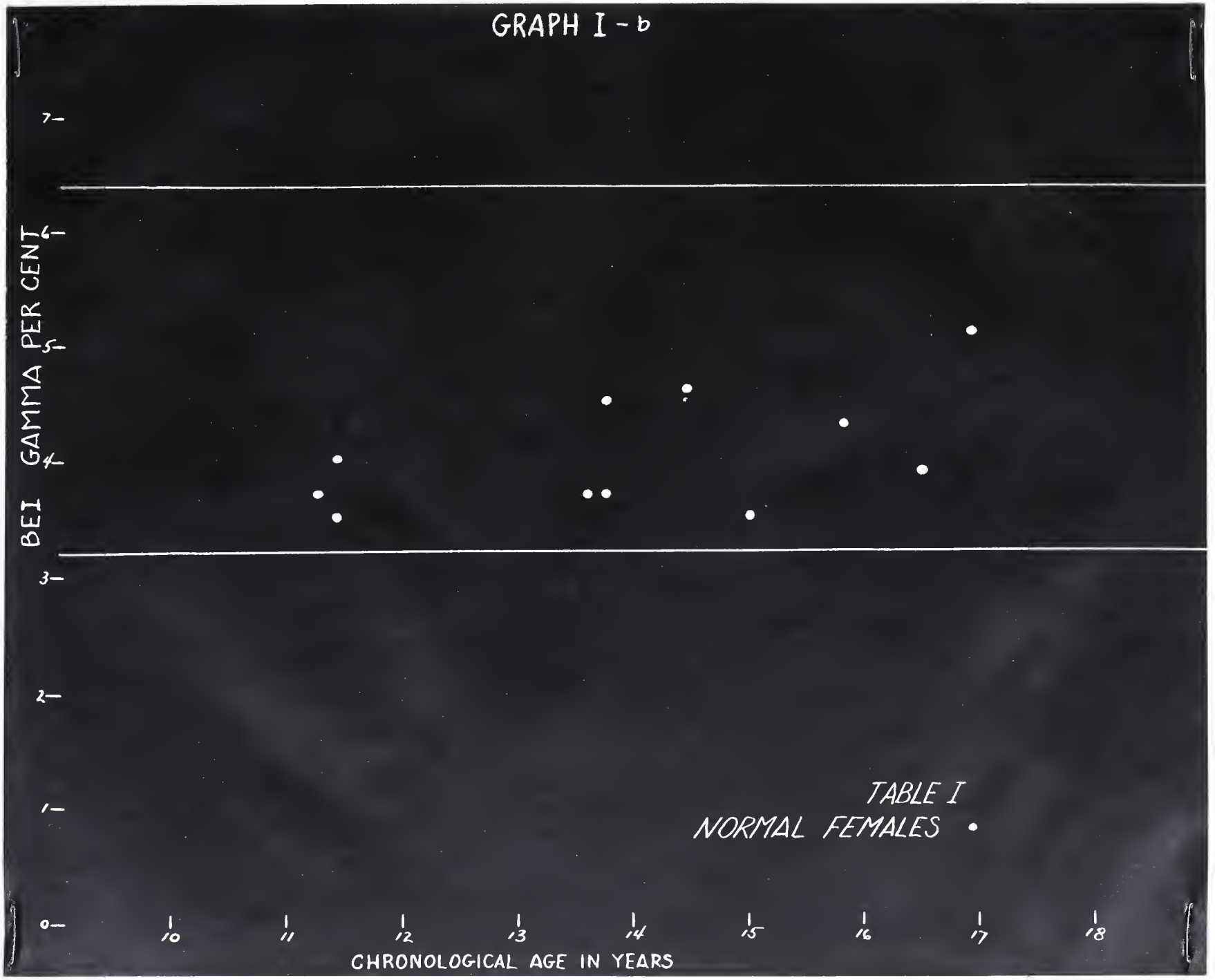
SUBJECT	Unit #	Birth Date	Date of Deter.	BEI	Chron. Age	Bone Age	Ht. & % Inches		Wt. & % Pounds		Secondary Sex Devel.	Purpose of BEI
MD	B 83825	12/13/35	7/25/46	3.9*	10'7"	--	--		---			Tachycardia
SJ	A 75588	7/26/37	4/25/50	4.7*	12'9"	--	61.7	70	144	97	Men. Reg.	Overweight
LG	B 51860	5/2/30	1/31/44	5.2*	13'8"	--	64	65	198	97	Men. Irreg.	Overweight
VH	48-28-90	2/17/41	1/31/58	4.7	17'	--	--	--	---	--		Obesity

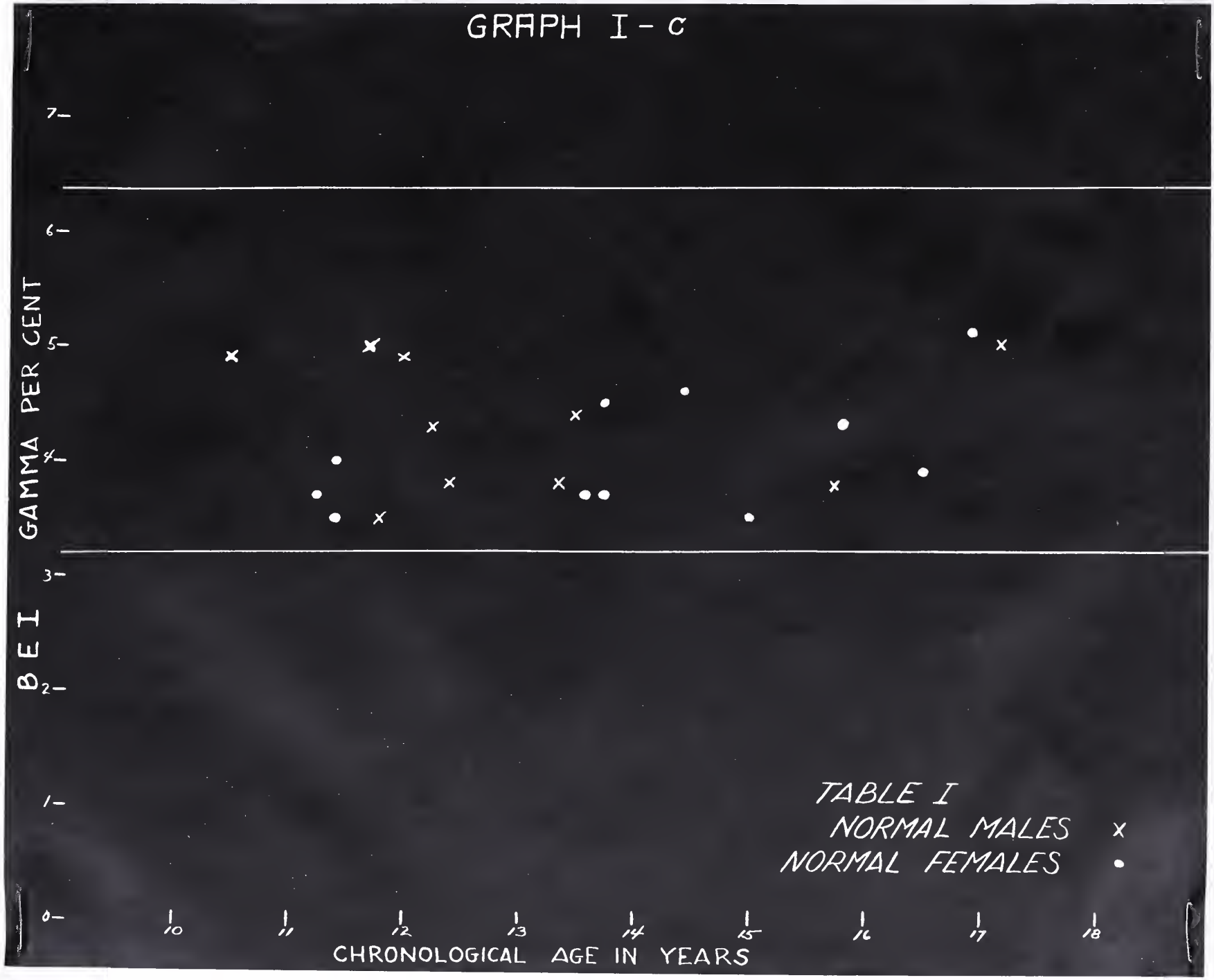
FEMALES POST RHEUMATIC FEVER

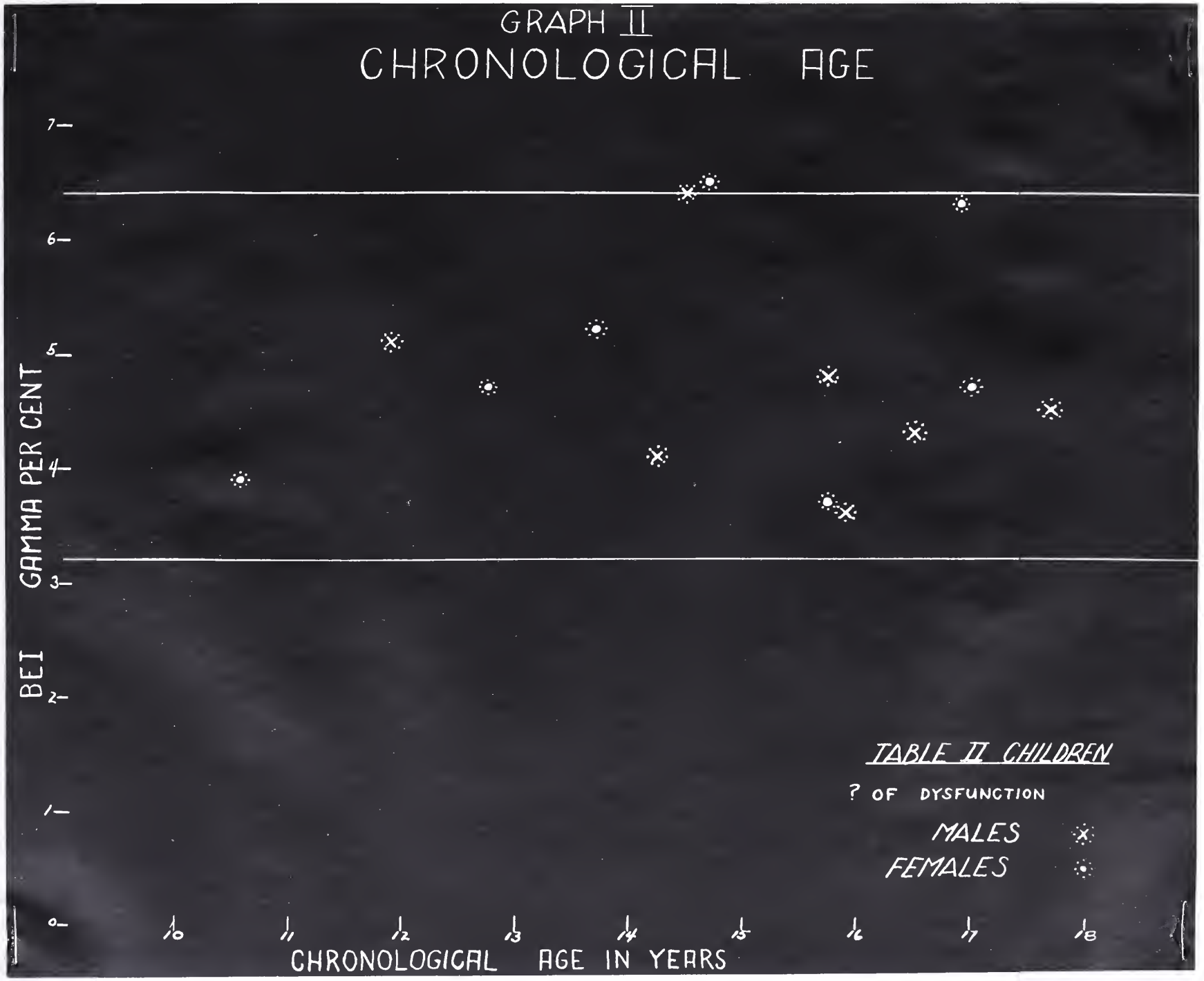
ES		2/22/39	8/11/53	6.5	14'8"		59	5	114	55	--	Normal Cont.
CC	38-48-99	4/24/42	1/7/58	3.7	15'9"	16	--	--	---	--	Men. Reg.	Normal Cont.
CM	38-63-43	2/13/41	1/21/58	6.3	16'11"	18	64	50	112	35	Men. Reg.	Normal Cont.

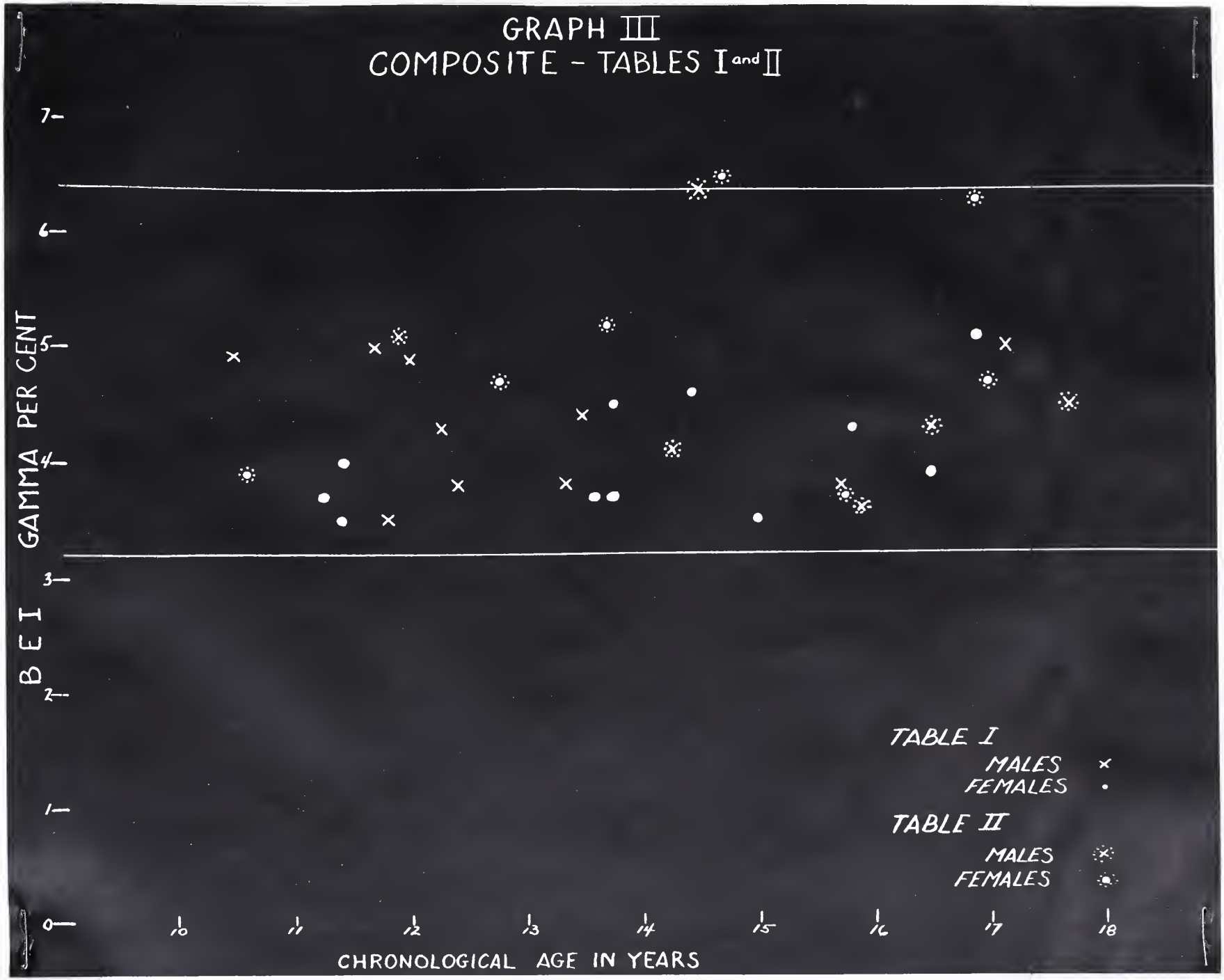
* Done as SPI

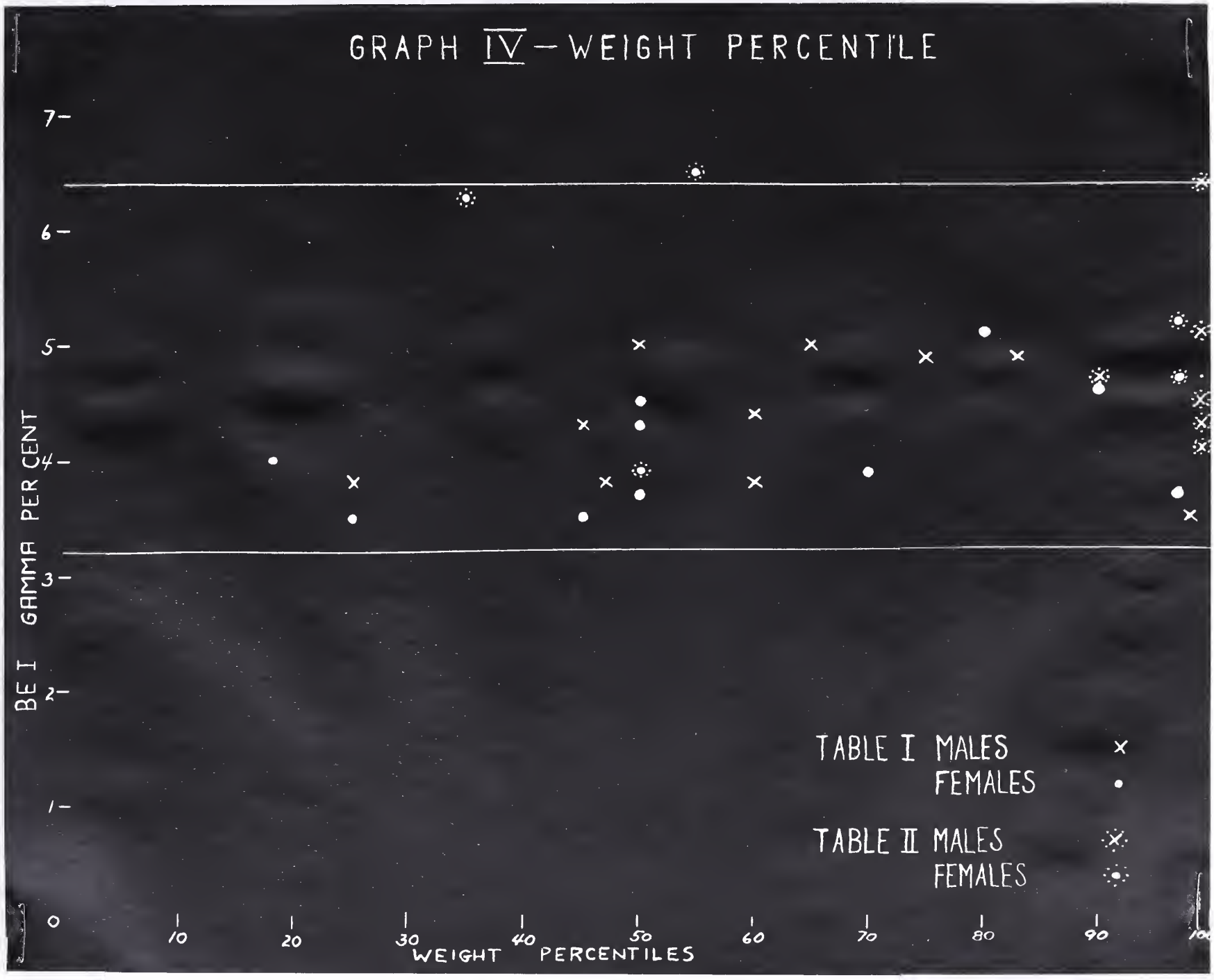

GRAPH I-a
CHRONOLOGICAL AGE
BEI GAMMA PER CENT
7
6
5
4
3
2
1
0
NORMAL ADULT RANGE
TABLE I
NORMAL MALES ×
10
11
12
13
14
15
16
17
18
CHRONOLOGICAL AGE IN YEARS

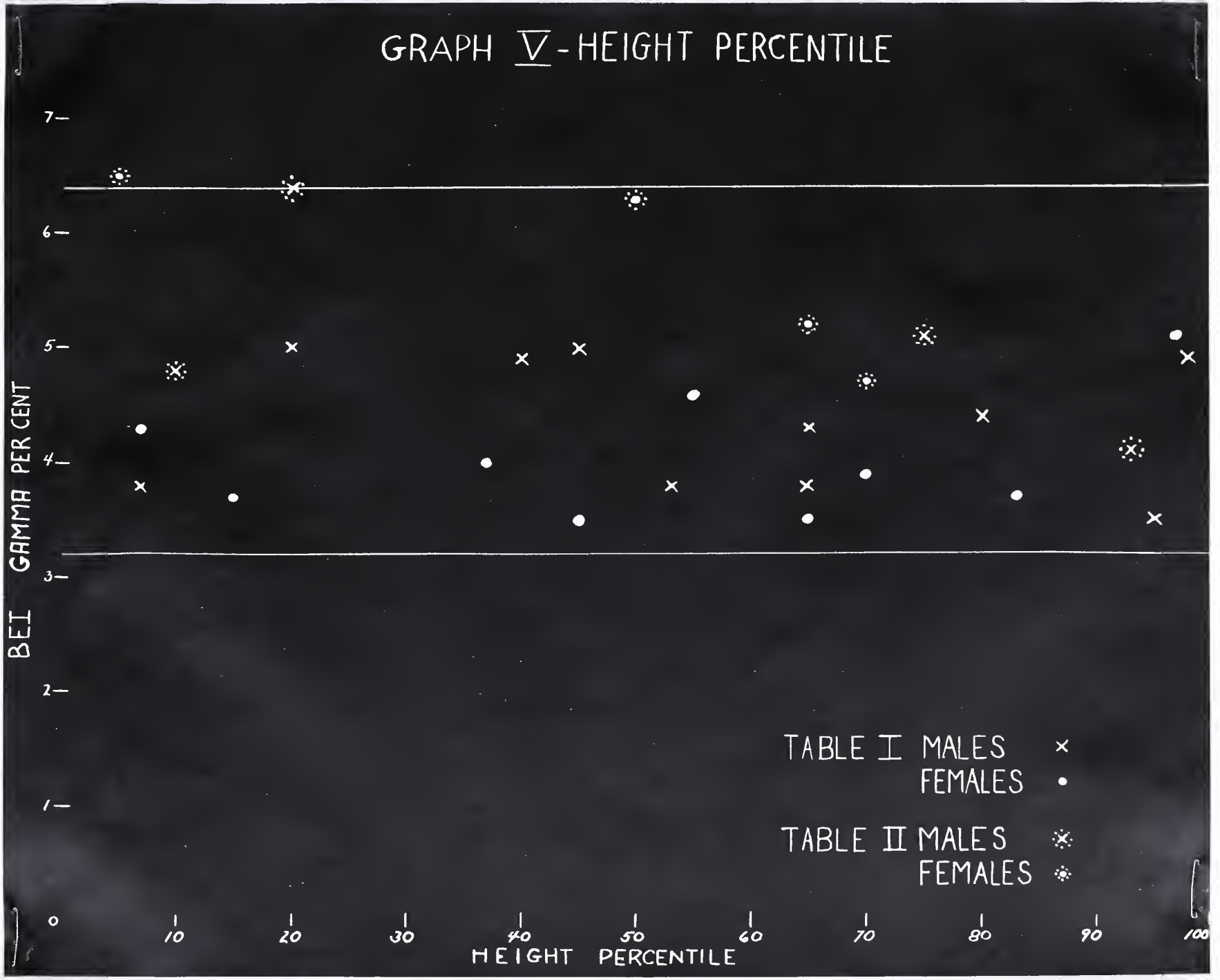

GRAPH I - b
BEI GAMMA PER CENT
7
6
5
4
3
2
1
0
10
11
12
13
14
15
16
17
18
CHRONOLOGICAL AGE IN YEARS
TABLE I
NORMAL FEMALES

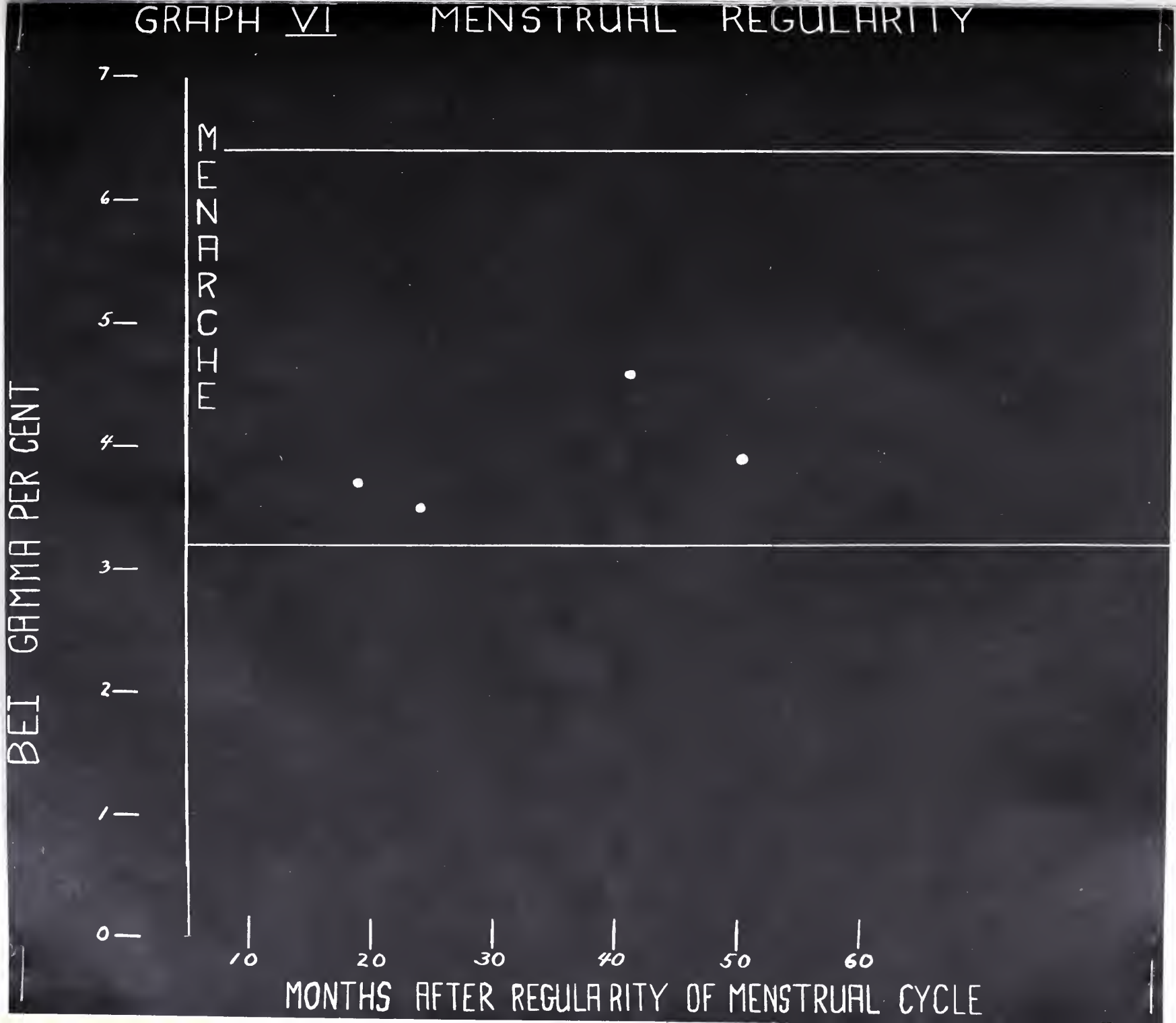

GRAPH I - C
BEI GAMMA PER CENT
7
6
5
4
3
2
1
0
10
11
12
13
14
15
16
17
18
CHRONOLOGICAL AGE IN YEARS
TABLE I
NORMAL MALES x
NORMAL FEMALES •

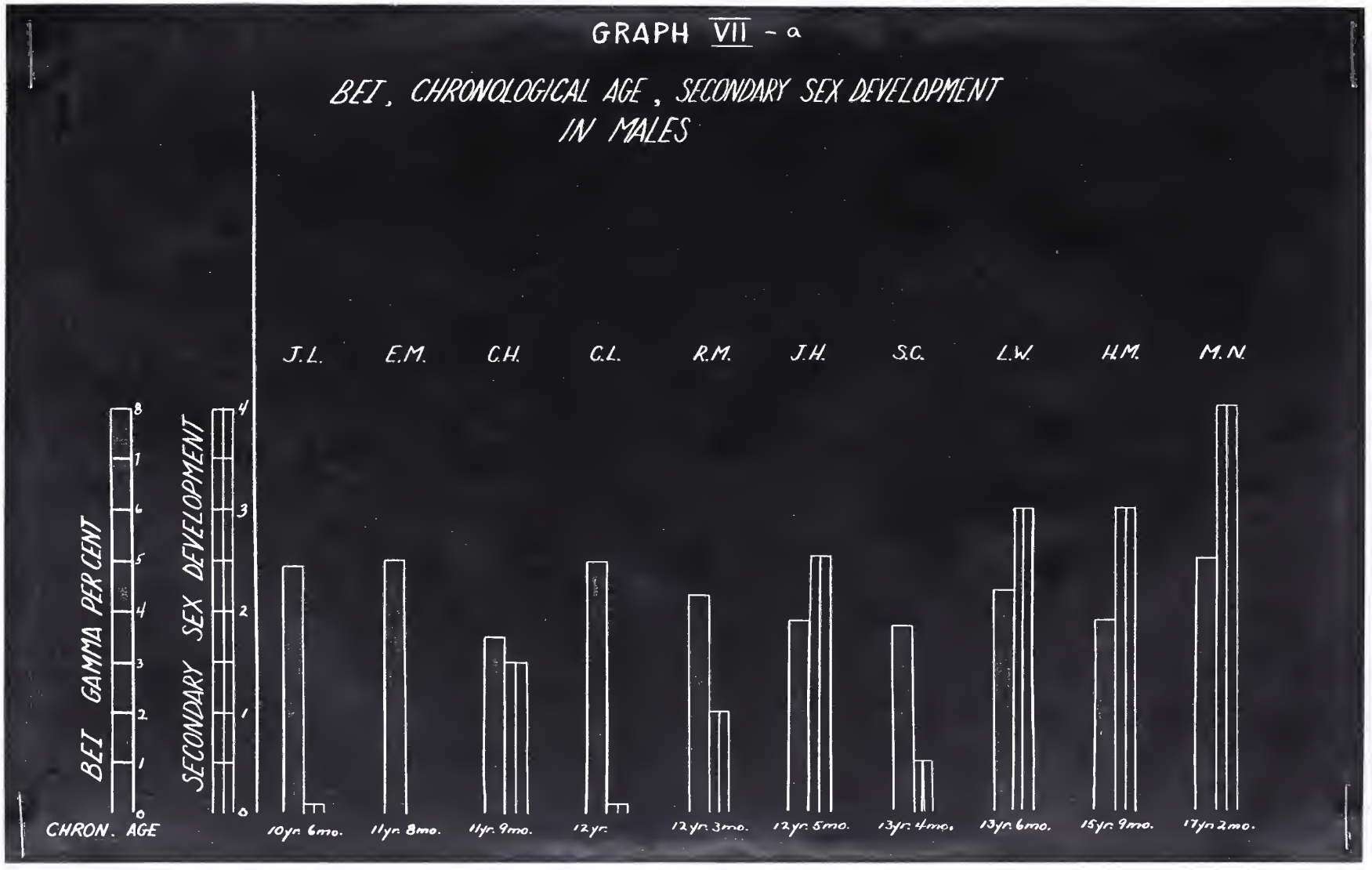

GRAPH II
CHRONOLOGICAL AGE
BEI GAMMA PER CENT
7
6
5
4
3
2
1
0
10
11
12
13
14
15
16
17
18
CHRONOLOGICAL AGE IN YEARS
TABLE II CHILDREN
? OF DYSFUNCTION
MALES
FEMALES


GRAPH III
COMPOSITE - TABLES I and II
BEI GAMMA PER CENT
7
6
5
4
3
2
1
0
10
11
12
13
14
15
16
17
18
CHRONOLOGICAL AGE IN YEARS
TABLE I
MALES
FEMALES
TABLE II
MALES
FEMALES


GRAPH IV — WEIGHT PERCENTILE
BE I GAMMA PER CENT
7
6
5
4
3
2
1
0
10
20
30
40
50
60
70
80
90
100
WEIGHT PERCENTILES
TABLE I MALES
FEMALES
TABLE II MALES
FEMALES

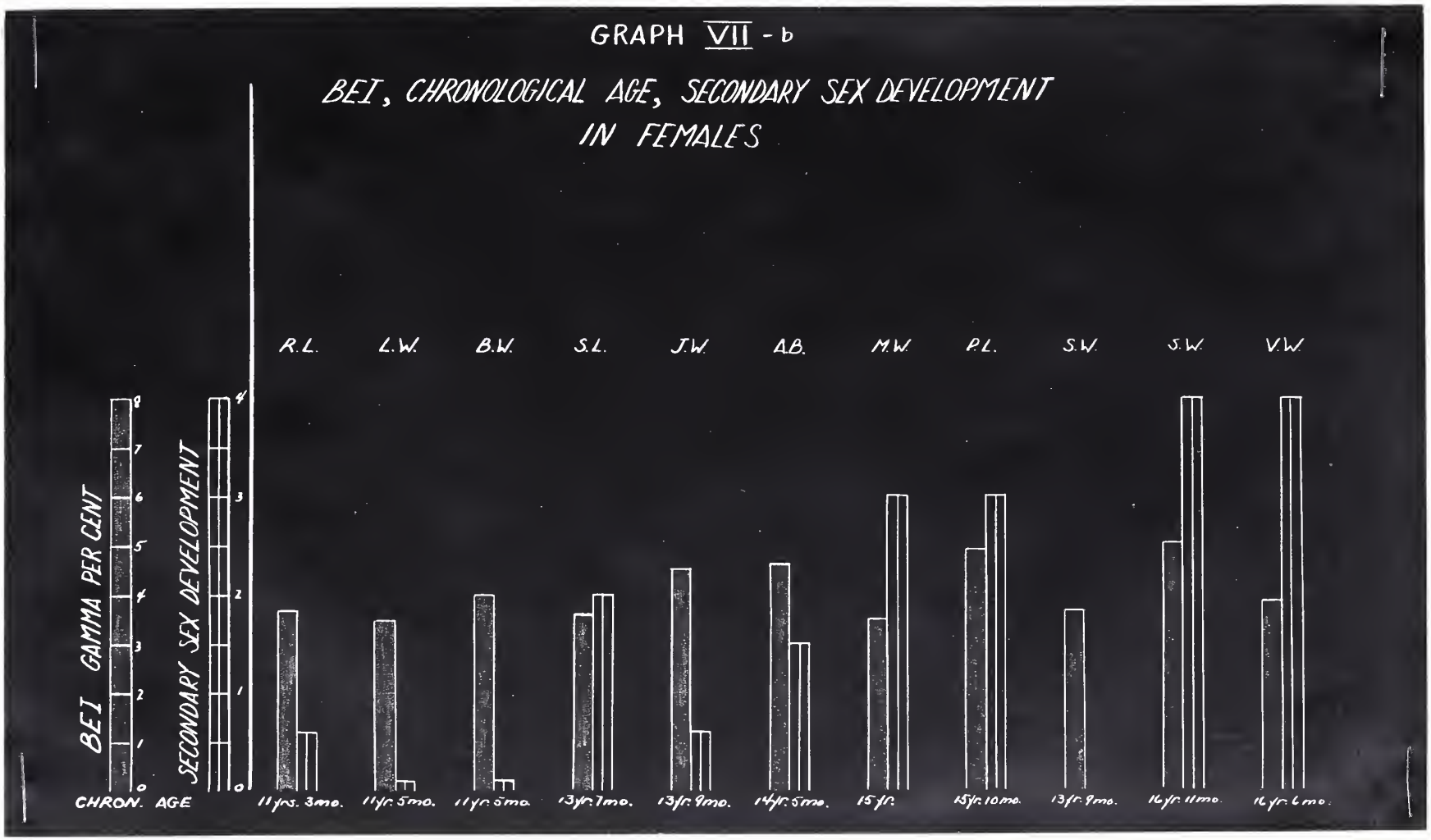

GRAPH V - HEIGHT PERCENTILE
BEI GAMMA PER CENT
7
6
5
4
3
2
1
0
10
20
30
40
50
60
70
80
90
100
HEIGHT PERCENTILE
TABLE I MALES
FEMALES
TABLE II MALES
FEMALES

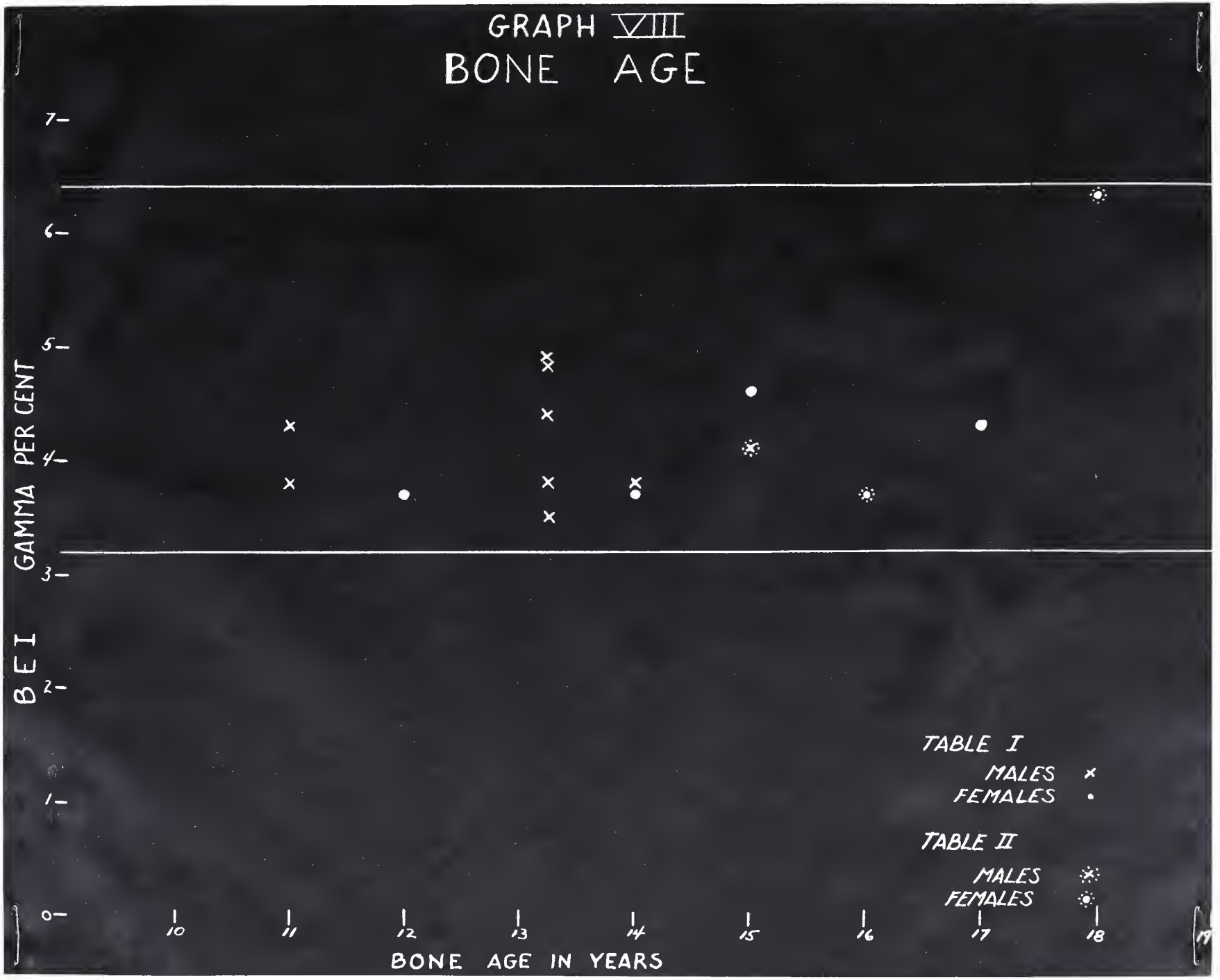

GRAPH VI MENSTRUAL REGULARITY
7
6
5
4
3
2
1
0
MENARCHE
BEI GAMMA PER CENT
10
20
30
40
50
60
MONTHS AFTER REGULARITY OF MENSTRUAL CYCLE


GRAPH VII - a
BEI, CHRONOLOGICAL AGE, SECONDARY SEX DEVELOPMENT IN MALES
BEI GAMMA PER CENT
SECONDARY SEX DEVELOPMENT
CHRON. AGE
J.L.
E.M.
C.H.
C.L.
R.M.
J.H.
S.C.
L.W.
H.M.
M.N.
10yr. 6mo.
11yr. 8mo.
11yr. 9mo.
12yr.
12yr. 3mo.
12yr. 5mo.
13yr. 4mo.
13yr. 6mo.
15yr. 9mo.
17yr. 2mo.

GRAPH VII - b

BEI, CHRONOLOGICAL AGE, SECONDARY SEX DEVELOPMENT IN FEMALES




GRAPH VIII
BONE AGE
7
6
5
4
3
2
1
0
BEI GAMMA PER CENT
10
11
12
13
14
15
16
17
18
BONE AGE IN YEARS
TABLE I
MALES
FEMALES
TABLE II
MALES
FEMALES

APPENDIX

NAME: PV'T. PED.

ADDRESS: DATE OF BIRTH

FAMILY HISTORY:

THYROID DISEASE
OTHER METABOLIC DISEASE
HYPERTENSION
DID MOTHER WHILE PREGNANT, OR PATIENT EVER LIVE IN GOITROGENOUS AREA

SIBLINGS' HEALTH GOOD

BIRTH HISTORY

ANY COMPLICATIONS AT DELIVERY

WAS PATIENT A PREMATURE BABY

DID MOTHER RECEIVE ANY MEDICATION FOR THYROID DYSFUNCTION

SOMATIC AND MENTAL DEVELOPMENT

HOW DOES PATIENT'S BUILD COMPARE WITH THAT OF OTHERS IN THE FAMILY

HOW ARE SCHOOL GRADES IN COMPARISON TO THOSE OF OTHERS IN THE SAME CLASS

INTERVIEWER'S ESTIMATE OF PATIENT'S INTELLIGENCE

HAS PATIENT HAD ANY RECENT ILLNESS OR INFECTION

ANY RECOLLECTION OF GROWTH SPURT

GIVE FIGURES AND DATES IF POSSIBLE

MENARCHE

AGE AT ONSET
AGE AT REGULARITY
DURATION OF PERIODS
DYSMENORRHEA
PREMENTRUAL TENSION

THYROID SYMPTOMS

SWEAT A LOT	ANY HEAT OR COLD INTOLERANCE		NERVOUS
TREMOR	LETHARGIC	EXCESSIVE WEIGHT GAIN OR LOSS	
DRY SKIN	HAIR COARSE	PERSONALITY CHANGE	

PHYSICAL

GENERAL DESCRIPTION

WT. HGT. P. BP

HAIR

SKIN

THYROID

HEART

PHYSICIAL DEVELOPMENT

BREASTS

AXILLA

PUBIS

FACE

PENIS

TESTES

Date Du

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